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Workshop on mobile laboratories deployed in the Ebola outbreak in West-Africa 2014-2015

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Ebola virus disease (EVD) is a haemorrhagic fever caused by Ebola virus (EBOV) with high infectivity and mortality [1]. EBOV is an enveloped, single-stranded, and negative-sense RNA virus belonging to the *Filoviridae* family [2]. In contrast to the genus Marburg virus which contains one single species, the genus Ebola virus contains 5 species: Zaire Ebola virus (ZEBOV), Sudan Ebola virus (SUDV), Taï Forest Ebola virus (TAFV), Bundibugyo Ebola virus (BDBV) which are pathogenic for humans, and Reston Ebola virus (RESTV) which infects non-human primates [3].

EBOV was first discovered in 1976 in the Democratic Republic of Congo (DRC) and simultaneously in Sudan [4,5]. Since 1976, EVD has appeared sporadically in DRC, Sudan, Gabon, Uganda, and Congo, with small to large outbreaks and lethality ranging from 50 to 100% [6,7] with about 2500 cumulative cases until 2013 [8].

Several studies suggest that EBOV is transmitted to humans from animals, and fruit bats are considered as probable reservoir [9,10]. Humans are infected through close contact with the organs, blood, and other biological fluids of infected animals and human-to-human transmission can occur through blood, body fluids or mucosal exposures [11,12]. The virus has been found in the blood, saliva, feces, breast milk, tears, and genital secretions of infected patients [8]. After an incubation period of 2-21 days, symptoms appear suddenly with fever, asthenia, headaches, myalgia, vomiting, diarrhea and bleeding in severe cases.

Treatment is largely through supportive care, such as rehydration and treatment of symptoms. Currently, several prophylactic or therapeutic strategies are being evaluated but none have been approved [13-16]. A Multi-factorial approach is therefore needed for EVD control, with laboratory surveillance and epidemiological investigation playing crucial roles in case confirmation and contact tracing. EVD diagnosis can be done only in specific laboratories and different tests to confirm EVD include antibody-capture enzyme-linked immunosorbent assay (ELISA) for antigen detection,, reverse transcriptase polymerase chain reaction (RT-PCR), real time RT-PCR assay for RNA detection and virus isolation by cell culture [17] and IgM/IgG detection for cases that have progressed beyond the diagnostic window for direct virus detection assays.

In March 2014 the WHO was notified of an EVD outbreak in Guinea caused by ZEBOV [18], which subsequently spread into other West African countries and developed into the largest outbreak recorded since the discovery of the virus.

The 2014 Ebola virus outbreak

An EVD outbreak started in December 2013 in Guéckédou, in the southeastern region of Guinea but was only identified and notified to the WHO in March 2014 due to a lack of diagnostic capacity and resources [18,19]. The first samples were sent to Institut Pasteur Lyon, France by MSF conducting an investigation in Guinea on behalf of the WHO. EBOV was confirmed in samples from infected patients and on March 23rd, 2014 the WHO publicly announced the outbreak in Guinea [19]. The first detection of the EVD on site in Guinea was done by the Institut Pasteur de Dakar deployment team on 23 March 2014 in Conakry.

The origin of the disease in West Africa rather than in central Africa, the delay in identification and the expansion into urban areas and neighbour countries (Liberia, Sierra Leone, Nigeria, Senegal and Mali) were particular features of this outbreak. WHO declared the outbreak a public health emergency of international concern on August 8th 2014 [19,20]. Up to January 31st 2016, 28 639 confirmed, probable and suspected Ebola cases and 11 316 deaths were reported [21]. In Guinea, Liberia and Sierra Leone a total of 3 804, 10 675, 14 124 confirmed cases, resulted in 2 536, 4 809, 3 956 deaths respectively (case-fatality rates 66.66%, 45.04%, 28.00%).

In the countries less affected, Nigeria, Mali, and Senegal, 20, 8, and 1 confirmed cases were reported, including, 8, 6, and 0 deaths. Case-fatality rates for these countries were 40%, 75%, and 0%, respectively [22]. Senegal was the fifth West African country to be affected but managed a rapid response due to the early alert given by public health staff in Guinea from where the index case was arriving [23].

In addition to West African countries, confirmed cases were reported in Spain, Italy, United Kingdom (1 case and 0 death for each country), and United States of America (4 cases and 1 death). Therefore this outbreak affected 10 countries in 3 different continents and this highlights how a disease known to be restricted to Africa can spread to many countries in the world through international travel.

The EVD outbreak in Liberia was declared over on 9 May 2015 [24]. However, the routine surveillance detected 6 new EVD cases

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from 29 June to 12 July and 3 in November 2015 [25,26]. Preliminary evidence from genomic sequencing strongly suggested that the most likely origin of transmissions was a re-emergence of the virus from survivors within Liberia [25,27]. Finally, the outbreak was declared over on 14 January 2016 [28].

In Guinea, the outbreak was declared over on 29 December 2015 [27]. In Sierra Leone, the outbreak was declared to have ended on 7 November 2015 and the country entered a 90-day period of enhanced surveillance. However, on 14 January, 68 days into the 90-day surveillance period, a new confirmed case of EVD was reported in Sierra Leone. Among the close contacts, one was tested also positive for Ebola virus on 20 January 2016 and the contacts of this last case were followed until February 11th.

Taken together, the situations in Liberia and Sierra Leone suggest that surveillance measures are essential to ensure the rapid detection of any reintroduction or re-emergence of EVD.

First EVD cases were reported from and the disease was limited to the Gueckedou, Guinean forests region until March 21st 2014. Due to the lack of appropriate health facilities in rural Africa, patients often visit capitals for better care. This led to the first case of Ebola recorded in a Conakry hospital on March 26th and chains of transmission of the disease in the capital were initiated through health care workers. Two major phases were observed during the Ebola epidemic in Guinea. The first phase covered the period March-July 2014 during which health personnel contributed considerably to the transmission of the virus [29]. This situation could be explained by several factors: Ebola was unknown in the region, its confusion with infectious diseases endemic in the region (malaria, etc.) and the lack of appropriate structures and equipment to manage patients.

During the second phase of the Ebola epidemic in Guinea, the most intense and longest phase, which began in August 2014 following the introduction of the virus via Sierra Leonne, funeral rites contributed to the spread of the disease in the country, as community members often touch and wash the body of the deceased, thus inadvertently initiating chains of transmissions.

In April 2015 a reinforced Ebola virus disease surveillance strategy with the aim of reaching the "zero case" goal set by the Ebola Emergency committee in Guinea was launched. For this purpose, all of the deceased in districts of Conakry most recently affected by the Ebola virus outbreak had to be tested. The field deployment of a mobile suitcase laboratory using RPA which provided results in 30-40 minutes helped to improve burial management and community engagement in the Matoto district in Conakry [30].

It is important to note that before 2014, Ebola epidemics were confined to rural areas. However, during the West Africa Ebola outbreak in 2014, large cities were affected including Conakry, Guinea's capital (population 2 million). Tracing the virus particularly contact follow-up in the 4 municipalities of Conakry in highly populated urban areas, were difficult and social reticence often reported. Local and international health personnel were often blamed to introduce Ebola virus responsible for the disease and the dead.

During the outbreak up to 24 organizations operated laboratories at 40 sites in Guinea, Sierra Leone and Liberia. In March 2016 representatives of ten organisations which had deployed (mobile) laboratories to 16 sites across the three countries in West-Africa (Table 1) convened for a two day symposium in Dakar (4-5.02.16) to exchange their experiences. The meeting was organized by the Ebola MODRAD consortium.

Table 1. Laboratories participating in the experience exchange.

Organisation	Laboratory placement in West -Africa
Guinea National Public Health laboratory &Institut Pasteur de Dakar, Senegal	Conakry, Guinea
Lassa Fever Diagnostic and Research Laboratory, Institute of Lassa Fever Research and Control, Irrua Specialist Teaching Hospital, Nigeria	Kambia&Western Area Urban, Sierre Leone
Institute Pasteur Lyon, France	Macenta, Guinea
Laboratory for Infectious Diseases and Screening, Centre for Infectious Disease Control, RIVM	Kono& Western Area Urban, Sierra Leone Grand Cape Mount, Liberia
European consortium with Bernhard-Nocht-Institute for Tropical Medicine, Germany	Gueckedou&Coya, Guinea Lofa, Liberia Western Area Urban, Sierra Leone
Public Health England, Porton Down, United Kingdom	Port Loko&Bombali, Sierre Leone
National Institute for Infectious Diseases "Spallanzani", Rome, Italy	Western Area Urban, Sierra Leone
Liberia National Public Health lab and USAMRIID, USA*	Margibi, Liberia
Center for Emerging and Zoonotic Diseases National Institute for Communicable Diseases Division in the National Health Laboratory Service Johannesburg & Sierra Leone Ministry of HealthLaboratory Technical Group	Western Area Urban, Sierra Leone

The meeting was also attended by representatives of Medicines sans frontiers and African colleagues of the Laboratoire de Bacteriologie Virologie, Universite Cheikh Anta DIOP, Dakar, Sengal, the Laboratoire de Bactériologie-Virologie, CHNU Aristide Le Dantec Dakar, Sengal the MRC West Africa Collaboration, Medical Research Council Unit, Gambia and the Institut National de Recherche Biomédicale, Kinshasa, DRC.

This special issue reports experiences made during the deployment and summarizes the discussion during the meeting which hopefully will help to optimize future deployments of this kind. This meeting did not assemble all organisations actively deploying mobile laboratories in the EVD outbreak in West Africa nor did all organisations choose to publish their experiences in this special issue. Additional publications on mobile laboratory deployments have been published in other journals [31-39].

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